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In the Specification:

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Figure 19a shows the physician's remote controller that has the same functionality inside as the physician's controller but with the addition of communication means such as telemetry or telephone modem;

Figure 19b shows an alternate embodiment of the physician's remote controller implemented by a standard notebook PC.

Figure 19c shows an alternate embodiment of the physician's remote controller implemented by a standard desktop PC.

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An external imager (111) sends an image in the form of electrical signals to the video data processing unit (113). The video data processing unit consists of microprocessor CPU's and associated processing chips including high-speed data signal processing (DSP) chips. This unit can format a grid-like or pixel-like pattern that is sent to the electrodes by way of the telemetry communication subsystems, external telemetry unit (118), and internal telemetry unit in internal implant (121). See Figure 1b. In this embodiment of the retinal color prosthesis ~~(Fig. 1b, (121))~~, these electrodes are incorporated in the internal ~~to the eye~~ implanted ~~part~~ 121.

These electrodes, which are part of the internal implant (121), together with the telemetry circuitry ~~(121)~~ are inside the eye. With other internally implanted electronic circuitry ~~(121)~~, they cooperate with the electrodes so as to replicate the incoming pattern, in a useable form, for stimulation of the retina so as to reproduce a facsimile perception of the external scene. The eye-motion (112) and head-motion (131) detectors supply information to the video data processing unit (113) to shift the image presented to the retina (120).

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Logarithmic encoding of light

In one aspect of an embodiment (Figure 1b), light amplitude is recorded by the external imager (111). The video data processing unit using a logarithmic encoding scheme (113) to convert the incoming light amplitudes into the logarithmic electrical signals of these amplitudes (113). These electrical signals are then passed on by external telemetry unit (118), (121), to the internal telemetry unit in internal implant (121) which results in the retinal cells (120) being stimulated via the implanted electrodes in internal implant (121), in this embodiment as part of the internal implant (121). Encoding is done outside the eye, but may be done internal to the eye, with a sufficient internal computational capability.

Energy and signal transmission

Coils

The retinal prosthesis system contains a color imager (Figure 1b, 111) such as a color CCD or CMOS video camera. The imaging output data is typically processed (113) into a pixel-based format compatible with the resolution of the implanted system. This processed data (113) is then associated with corresponding electrodes and amplitude and pulse-width and frequency information is sent by telemetry (118) into the internal unit coils, (311), (313), (314) (see Figure 3a). Electromagnetic energy, is transferred into and out from an electronic component (311) located internally in the eye (312), using two insulated coils, both located under the conjunctiva of the eye with one free end of one coil (313) joined to one free end of ~~the~~ a second coil (314), the second free end of said one coil (313) joined to the second free end of said second coil (314). The second coil (314) is located in proximity to an internal coil (311) which is a part of said internally located electronic component, or, directly to said internally located electronic component ~~(311)~~. The larger coil is positioned near the lens of the eye. Said one coil, ~~T~~the larger coil, is fastened in place in its position near the lens of the eye, for example, by suturing. Figure 3b represents an embodiment of the telemetry unit temporally located near the eye, including an ~~external temporal~~ primary coil (321), an internal (to the eye) coil (312), an external-to-the-eye electronic chip (320), dual coil transfer units (314, 323), (321,322) and an internal-to-the-eye electrode array (325). The advantage of locating the external electronics in the fatty

tissue behind the eye is that there is a reasonable amount of space there for the electronics and in that position it appears not to interfere with the motion of the eye.

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Said elongated electrodes in an aspect of this of an embodiment of this invention may be of all the same length. In a different aspect of an embodiment, they may be of different lengths. Said electrodes may be of varying lengths (Figure 8b and 8c, ~~820~~818), such that the overall shape of said electrode group conforms to the curvature of the retina (814). In either of these cases, each may penetrate the retina from an epiretinal position (Figure 8a, 811), or, in a different aspect of an embodiment of this invention, each may penetrate the retina from a subretinal position (Figure 9b, 817).

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Platinum electrodes

Figure 11 (a-e) demonstrates a preferred structure of, and method of, making, spiked and mushroom platinum electrodes. Examining Figure 11a one sees that the support for the flat electrode (11093) and other components such as electronic circuits (not shown) is the silicon substrate (1101). An aluminum pad (1102) is placed where an electrode or other component is to be placed (1102). In order to hermetically seal-off the aluminum and silicon from any contact with biological activity, a metal foil (1103), such as platinum or iridium, is applied to the aluminum pad (1102) using conductive adhesive (1104). Electroplating is not used since a layer formed by electroplating, in the range of the required thinness, has small-scale defects or holes which destroy the hermetic character of the layer. A titanium ring (1105) is next placed on the ~~platinum or iridium~~ metal foil (1103). Normally, this placement is by ion implantation, sputtering or ion beam assisted deposition (IBAD) methods. Silicon carbide, diamond-like coating, silicon nitride and silicon oxide in combination, titanium oxide, tantalum oxide, aluminum nitride, aluminum oxide or zirconium oxide (1106) is placed on the silicon substrate (1101) and the titanium ring (1105). In one embodiment, an aluminum layer (1107) is plated

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onto exposed parts of the titanium ring (1105) and onto the silicon carbide, diamond-like coating, silicon nitride and silicon oxide in combination, titanium oxide, tantalum oxide, aluminum nitride, aluminum oxide or zirconium oxide (1106). In this embodiment the aluminum (1107) layer acts as an electrical conductor. A mask (1108) is placed over the aluminum layer (1107).

In forming an elongated, non-flat, electrode platinum (Figure 11b) is electroplated onto the ~~platinum or iridium~~ metal foil (1103). Subsequently, the mask (1108) is removed and insulation (1110) is applied over the platinum electrode (1109).

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Inductive coupling coils

Information transmitted electromagnetically into or out of the implanted retinal color prosthesis utilizes insulated conducting coils so as to allow for inductive energy and signal coupling. Figure 12 shows an insulated conducting coil and insulated conducting electrical pathways, e.g., wires, attached to substrates at what would otherwise be electrode nodes, with flat, recessed metallic, conductive electrodes (1201). In referring to wire or wires, insulated conducting electrical pathways are included, such as in a "two-dimensional" "on-chip" coil or a "two-dimensional" coil on a polymide substrate, and the leads to and from these "two-dimensional" coil structures. A silicon carbide, diamond-like coating, silicon nitride and silicon oxide in combination, titanium oxide, tantalum oxide, aluminum nitride, aluminum oxide or zirconium oxide (1204) is shown acting as both an insulator and a hermetic seal. Another aspect of the embodiment is shown in Figure 12a. The electrode array unit (1201) and the electronic circuitry unit (1202) can be on one substrate, or they may be on separate substrates ~~(1202)~~ joined by an insulated wire or by a plurality of insulated wires (1203). Said separate substrate units can be relatively near one another. For example they might lie against a retinal surface, either epiretinally or subretinally placed. Two substrates units connected by insulated wires may carry more electrodes than if only one substrate with electrodes was employed, or it might be arranged with one substrate carrying the electrodes, the other the electronic circuitry. Another arrangement has the electrode substrate or substrates placed in a position to stimulate the retinal cells, while the electronics are located closer to the lens of the eye to avoid heating the sensitive retinal tissue.

In all of the Figures 12a, 12b, and 12~~c~~d, a coil (1205) is shown attached by an insulated wire. The coil can be a coil of wire, or it can be a "two dimensional" trace as an "on-chip" component or as a component on polyimide. This coil can provide a stronger electromagnetic coupling to an outside-the-eye source of power and of signals. Figure 12d shows an externally placed aluminum (conductive) trace instead of the electrically conducting wire of Figure 12c. Also shown is an electrically insulating adhesive (1208) which prevents electrical contact between the substrates (1202) carrying active circuitry (1209), except where connected by aluminum trace (1207).